



CHEMICAL CONTROL OF PLANT GROWTH IN LANDSCAPES

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Controlling the size of mature plants

... in such man-made landscapes as streets, freeways, and parks is costly and often hazardous when conventional methods of pruning and disposal are used

Chemical control

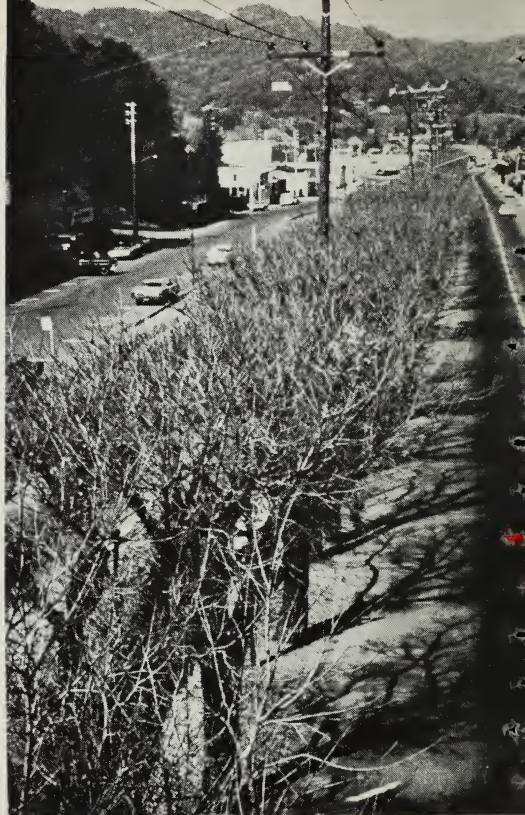
... of these landscapes offers possibilities of being less expensive and dangerous

This bulletin

- discusses the three major factors involved in chemical control of landscapes
- profusely illustrates actual results of such control
- names plant species known to be controllable

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CHEMICAL CONTROL OF PLANT GROWTH IN LANDSCAPES¹

Restricting the size of mature plants under power lines, along city streets and highways, in parks and cemeteries, and in other man-made landscapes is an expensive and difficult maintenance problem which promises to increase in direct proportion to increases in population and public services. Proper selection of plant species (taking into consideration their size at maturity and their growth rate) will often minimize problems of overgrowth. In many cases, however, large trees or plants are either desirable or already present, and removing them would arouse public protest. Other prob-

lems arise—for example, the oleander is useful as a headlight “screen” on the median strips of freeways, but within 10 years after planting it becomes so large that its growth must be controlled. Ordinary methods of pruning and removing excess plant growth on freeways and in certain other areas are costly and hazardous, and there is need for improvement in this field. One utility company has recently instructed all companies contracting for line-clearance operations to include a program in chemical control to accompany traditional tree-trimming methods.

MALEIC HYDRAZIDE AS A GROWTH REGULATOR

Maleic hydrazide (MH) is used to control sprouting of potatoes and onions and suckering (axillary bud growth) of topped tobacco. In the eastern U. S. it has proved an effective inhibitor of grass along highways, airport runways, etc., but in the western U. S. effective growth-control applications usually mar the appearance of the grasses. More recently it has been used to control growth in many woody ornamental species. Most estimates suggest that the cost of MH spraying is usually 10 to 14 per cent of tree trimming, and sometimes as low as 5 per cent. Cost of MH spraying per tree is dependent on several factors including number of trees sprayed, size of trees, and efficient use of spray solutions. Figures compiled by one utility company showed that cost per tree varied from \$0.59 to \$5.03 depending on the number of trees sprayed (decreasing with increasing number of trees) and the amount of spray solu-

tion applied per tree. Gallons of spray solution per tree varied from 0.6 to 4.6.

The three major problems to be discussed are:

- time of application with respect to the plants annual growth-cycle
- optimal concentration of chemicals
- frequency of application

In order to have a landscape look its best it is advisable to plan separate maintenance programs for trees and shrubs to be viewed from more than 25 feet away (the “distant landscape”), and for those to be viewed at closer range (the “near landscape”). This is because MH most effectively controls growth by killing tips of shoots, with resultant unsightliness when viewed from closer than about 25 feet. Reduced MH dosage reduces tip dieback. Plants controllable with MH are listed starting on page 16.

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MH IN THE DISTANT LANDSCAPE

Large trees, regardless of location, and hedgerows on highways, racetracks, etc. can be considered part of the distant landscape. MH-induced death of shoot tips in these is rarely noticed.

Application times for deciduous trees and shrubs

Because improper timing can result in unnecessary damage or reduced effectiveness of treatment, time of application is a critical factor. Excessive damage occurs when MH is applied to deciduous species before new leaves have expanded in the spring. MH prevents or decreases the rate of new cell formation in plant tissues, thus stopping stem elongation and preventing growth of young leaves. As a result, MH-treated plants may remain barren until new shoots form; in one case in Marin County MH applied to sycamores in early spring delayed leaf formation for 3 months. Applied after leaf expansion but before extensive stem elongation, MH kills or slows growth of the terminal bud and prevents further stem elongation without damaging expanded leaves. Viewed from more than 25 feet, damage to the terminal bud and unexpanded leaves is rarely noted even by trained observers. Late applications, when the stem has al-

most ceased elongating and leaf formation has nearly stopped, may have less effect in controlling growth—in some cases leaf initiation is delayed the following spring, but usually the effect (if any) is to reduce stem elongation and the numbers of leaves initiated. Late applications are never as effective as those made at the optimal stage discussed in the second paragraph below.

Species differ in their growth characteristics. For example, shoot growth in the spring is not the same for all species, and moreover the same species in different climates exhibits different annual growth cycles. Hence, the calendar cannot be used to determine optimal application dates. Spray recommendations should pertain to stage of growth only—namely, to the number of leaves present.

How does one know when to apply MH to deciduous species in the spring? To begin with, a visual estimate of the “fullness” of the tree should be made. Fullness, a subjective term, must be defined for each species by the interested parties (for example, the street-tree committee and the contractor). When trees are judged to be full, the number of fully expanded leaves on ten newly-formed shoots on two trees of the same species should be recorded—spraying should commence when that number is attained each spring. Thus,



Fig. 1. Sycamore trees pruned in April. Trees on the left sprayed with MH in July; photograph made the following April. Note new growth on both rows of trees, and inhibition of branch elongation on treated trees. (Courtesy Sohner Tree Service.)

Fig. 2. American elms last pruned in March, 1964, and sprayed annually thereafter with MH. Photo taken in May, 1968. Note that line clearance is nearly unchanged since original pruning. (Courtesy Sohner Tree Service.)



spraying dates are made independent of the weather or climate and become species specific. For example, black walnut trees might be judged full (and ready for spraying) when they have an average of ten fully expanded leaves. This leaf complement may be attained on May 1 in Chico, but not until June 15 in San Jose. However, the following year black walnuts in San Jose might have ten fully expanded leaves on June 1 and therefore should be sprayed on that date.

The diagram on page 7 illustrates the effects of MH in relation to time of application. With proper application timing, new buds in axillary positions below dead terminal portion of the branch commence growth the following spring. The photographs on page 6, which were taken in early and late spring the year following treatment with MH, show axillary buds growing below dead terminals; if MH had been applied again (after leaf expansion) the terminal portions of these new axillary shoots would have been killed. As MH treatments continue, trees or shrubs appear more compact because of increased axillary branching and terminal bud death. The effect of annual MH treatments is similar to the annual removal of

the terminal bud by mechanical pruning, and so such treatments usually keep trees at their last-pruned height for several years.

Applications made too late in the growing season may be totally ineffective in inhibiting growth because (1) the current year's growth may be completed, (2) the older foliage may absorb less MH, and (3) the terminal bud may have a protective covering of scales or wax, or it may be



Fig. 3. Optimum stage of growth of black walnut for most effective MH treatment. New growth is 12 inches long; there are 9 to 10 fully expanded leaves.



Fig. 4. Tip die-back in treated trees. Top left: sycamore; top right: black walnut; bottom left: Shamel ash; bottom right: American elm. Photos made the year following MH application. (Sycamore photo courtesy Sohner Tree Service.)

dormant and survive to continue growth the following spring. This last is the most serious: without terminal dieback clearance achieved by the last pruning is rapidly lost. Again the importance of proper stage of development at treatment time is emphasized.

Application times for evergreen trees and shrubs

To achieve maximum inhibition of growth in evergreen shrubs and trees, MH should be applied after pruning or in spring when axillary buds commence growth. There are three reasons for this:

- newly developing leaves absorb MH more readily than do the fully expanded leaves
- MH inhibition occurs in terminal buds, close to the site of absorption in newly developing leaves
- applications during bud break prevent new shoots from elongating beyond the desired hedge line.

This last factor is particularly important in rapidly-growing species, such as cotoneaster, pyracantha, and xylosma. Earlier applications at pruning time or in winter or later ones in summer are less effective for stopping or slowing growth.

In evergreen or deciduous species having no true dormancy (that is, when shoot growth from terminal or axillary buds is intermittent throughout the growing season), timing of application is not critical even though multiple applications are usually required. In eucalyptus, for example, axillary buds will start growing shortly after the terminal is killed by MH as long as the temperature is above the minimum for growth. Eucalyptus in Marin County may sometimes require two to three applications at 60- to 90-day intervals for annual control.

Fig. 5. Diagrammatic sketches (below) of branches treated with MH showing effect as related to time of application. Dashed lines indicate level from which growth started in 1969. Spray dates are hypothetical.

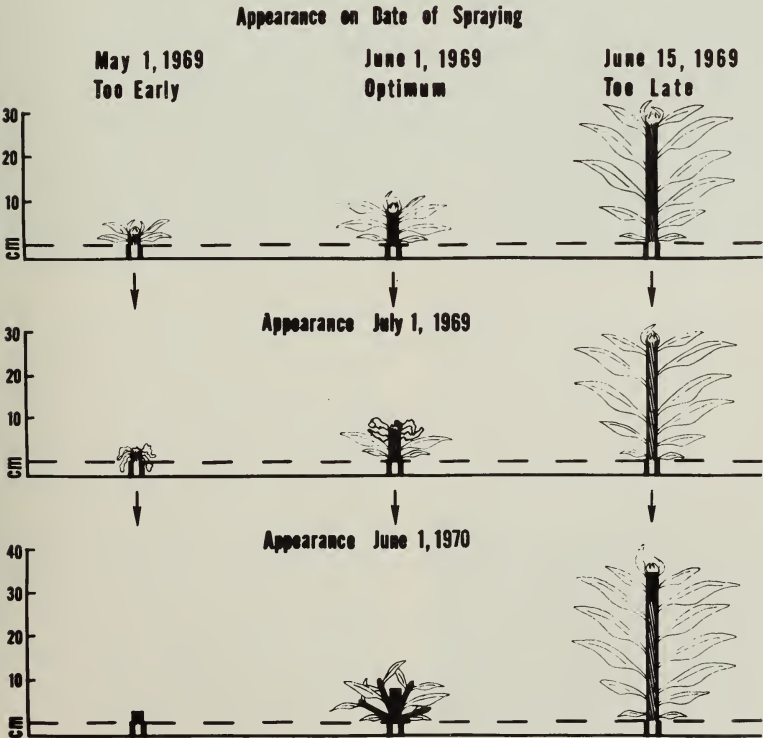


Fig. 6. *Cotoneaster pannosa* treated with 0.1 per cent MH-30. The shorter plant is the treated one. Treatment began 5 days after bud break and was repeated at 45-day intervals. Photos taken 4 months after April pruning. Note excellent growth control obtained.



Whenever a plant, evergreen or not, makes a single, annual flush of growth it should be treated as a deciduous species. That is, MH should be applied *after* leaf renewal.

Dosage

Dosages for MH must be based on the amount of MH in the product purchased. The most common formulation contains 30 per cent MH (called MH-30® or Slo-Gro®), and the dilutions discussed here refer to this product. The manufacturer suggests diluting $1\frac{1}{3}$ gallons of MH-30 in 100 gallons of spray solution to make a

1.33 per cent solution. This is a highly effective solution where single annual applications are used, but we have found that lower dosages may be more advantageous for certain species. Conifers in particular are frequently damaged by 1.33 per cent MH-30, but in nursery trials good growth control and much less needle discoloration is observed at 0.1 per cent to 0.25 per cent. Growth inhibition at this lower rate persists in many pine and juniper species for at least 4 months; this suggests that adequate control could be achieved with single annual applications or perhaps two applications, one in early spring and one in summer.

Fig. 7. *Rhamnus alaternus* treated with 0.1 per cent of MH-30. The shorter plant is the treated one. Treatment began 5 days after bud break and was reported at 45-day intervals. Photo taken 4 months after April pruning.



Whenever multiple applications are necessary to control axillary branch development, lower dosages should be used. Field tests with *Ulmus parvifolia* show that dosages in excess of 0.25 per cent MH-30 may cause severe damage to mature leaves and delay leaf initiation the following spring. At 0.1 to 0.25 per cent MH-30 excellent control was obtained with little damage and no delay in leaf initiation. Nursery trials with container-grown *Eucalyptus viminalis* suggest that 0.1 per cent MH-30 is more than adequate to inhibit growth for 60 days or longer. Higher dosages may be tolerated by field-grown plants, but may not be more effective for inhibiting growth.

Fig. 8. Needle discoloration on Monterey pines (photo below) which were treated with 1.33 per cent MH-30 in July. The photo was taken in October. (Courtesy Sohner Tree Service.)





Fig. 9. Above: MH-induced inhibition of growth in *Juniperus sabina tamariscifolia*. Plant 2 treated with 0.25 per cent MH-30 in March; plant 1 was untreated. Note retention of juvenile foliage in MH-treated plant. Photo taken in October. Similar control will result with 0.1 per cent treatment.

Fig. 10. Siberian elms (foreground) treated with 0.5 per cent MH-30 in July; photo taken April of the following year. Note relative lack of leaves on the treated plants; leaves appearing on treated plants are on branches arising 8 to 12 inches below the pruning line.

Fig. 11. Siberian elms (foreground) treated with 0.1 per cent MH-30 in July; photo taken in April of the following year. Note excellent inhibition of stem elongation and near-normal leaf initiation. Compare appearance of treated plants with treated plants shown in figure 10.



MH IN THE NEAR LANDSCAPE

Multiple applications of 1.33 per cent MH-30 usually kills the terminal bud and several inches of the stem below and often causes foliar discoloration. This considerably lessens the value of MH in carefully tailored near landscapes, although such damage may sometimes be tolerated because some rapidly growing shrubs recover their appearance in a few weeks. Lower dosages applied more than once during the growing season reduce die-back and discoloration considerably and still provide adequate growth control. Average branch lengths of some treated plants are shown on page 18.

Time of application and dosage

As was pointed out in the section on application times for evergreen trees and shrubs in the distant landscape, maximum inhibition of growth is achieved by applying MH after pruning or in spring when axillary buds commence growth. Application frequency in the near landscape should be based on climate and branch growth rather than on the calendar. Thus, respraying should be done when new branches pass the original line of pruning by 1 to 4 inches (or whatever is acceptable). For example, more frequent applications were needed on *Cotoneaster pannosa* in Davis than in Los Angeles or Santa Ana where the climate is cooler and the growth rate slower. Weather conditions at the time of application can also influence effectiveness of MH applications through their effect on rate of drying and absorption by the leaves.

Addition of surfactants to MH spray solutions increases their effectiveness so that lower dosages may be recommended and phytotoxicity reduced. For maximum effectiveness of MH (i.e., the lowest dosage required to achieve desired inhibition), 0.1 to 0.25 per cent surfactant should be incorporated in all MH formulations.

The 0.25 per cent MH-30 treatments at 45- to 60-day intervals (photos, page 12) maintain hedge lines without causing chlorosis or necrosis in young foliage of most species. Even in *cotoneaster* the dam-

age is greatly reduced at this low level, although new growth from the terminal

SURFACTANT ENHANCEMENT OF MH-ACTIVITY

Species	Per cent growth inhibition*	
	No surfactant	0.25 per cent surfactant
<i>Cotoneaster pannosa</i>	7	53
<i>Nerium oleander</i>	0	43
<i>Pyracantha coccinea</i>	0	43

* 0.25 per cent MH-30 applied twice; growth measured 3 months after initial application.

bud present at the time of treatment, or from axillary buds below, is abnormal. Internodes are longer and leaf blades smaller in MH-treated plants, giving a sparser, twiggy appearance to the new growth; however, the entire shrub takes on a denser habit of growth (see section below on rejuvenation of shrubs and hedges). In *cotoneaster* and species having a similar response to MH (such as *pyracantha*), other treatments may be preferred. Nevertheless, our studies suggest that after initial shaping of the hedge of many evergreen species, MH may be used at low dosages in the near landscape to eliminate or sharply reduce pruning. In *pyracantha* and *cotoneaster*, light pruning to remove deformed branches is advisable.

Another successful MH-treatment for evergreen species has been August or September pruning, followed by a September or October spray using 0.5 to 1.33 per cent MH-30. At these dosages MH completely stops growth for 6 to 7 months by killing the terminal bud and preventing axillary bud break until the following spring. Foliar discoloration or abnormal growth is less than is usual with spring applications at such rates. New growth in



Fig. 12. *Viburnum japonicum* hedge treated (foreground) with 0.25 per cent MH-30 at 60-day intervals. Note excellent growth control.



Fig. 13. Italian buckthorn hedge treated (left) with 0.25 per cent MH-30 at 60-day intervals. Note excellent growth control with little foliar damage; young leaves are lighter green but still attractive.



Fig. 14. *Cotoneaster parneyii* hedge treated (left) with 0.25 per cent MH-30 at 60-day intervals. Excellent growth control achieved, but terminal buds are damaged or killed.



Fig. 15. Above (left photo): untreated and treated branches of *Cotoneaster pannosa*. Two treated branches shown on right in photo; branch on far right shows type of shoot development found when terminal bud is killed; branch to the left of it shows growth resulting when shoot is damaged, or when an axillary bud breaks on treated



branch. Note MH-induced reduction in leaf expansion and increased internode length. New growth on treated plants is usually much more sparse than on untreated plants.

Fig. 16. Above (photo on right): treated *Viburnum* hedge branch (right) and untreated *Viburnum* (left). Growth habit, leaf size, and color of both treated and untreated branches are the same.

Fig. 17. Left to right, below: *Rhamnus alaternus* and *Cotoneaster pannosa* hedges in foreground sprayed with 0.5 per cent MH-30 in October after pruning in September (photos taken in April).





Fig. 18. *Ligustrum lucidum* hedge in foreground was sprayed with 0.5 per cent MH-30 in October after pruning in September. The original trim line was maintained for several weeks in the following spring, as shown by this photograph taken in April.

spring arises from axillary shoots only, below the original cuts; thus, bud break is delayed and the original trim line is maintained for several weeks after spring growth commences. Subsequent treatments at 0.25 per cent MH at 45- to 60-day intervals (or whenever growth resumes) can maintain the hedge at essentially the desired size and shape.

Rejuvenation of shrubs and hedges

MH-treated hedges maintain or increase in fullness as do frequently pruned hedges. Axillary growth from below renews the internal branching and foliage; in fact, MH-treatments of old shrubs having extremely heavy, barren branches increases

Fig. 19. Increased branching on heavy branches of old pyracantha shrubs resulting from MH treatment. Left photo: initiation of new shoots near base of old branches. Right photo: the base of the shrub pictured here has filled in with new shoots.



axillary branching and foliar density from the base to the desired height more rapidly than does pruning alone. This is because the axillary buds on each branch begin to

grow when the terminals on the branches are inhibited by MH. The hand labor which would be required to accomplish the same job would be extremely costly.

HEALTH, LONGEVITY, AND FLOWERING OF MH-TREATED PLANTS

Long-term MH treatments (12 years or more) show no adverse effects on longevity of healthy shrubs. However, MH should not be applied to trees or shrubs which are diseased (as indicated by weak growth and dead branches) as this may hasten the death of diseased parts or plants.

Foliar discoloration caused by low temperatures has been observed in MH-treated *Callistemon citrinus* (bottlebrush), *Pittosporum undulatum*, and *Viburnum japonicum*. Such effects will probably be observed in other tropical or sub-tropical species during cold winters; however, we have not observed permanent damage in the three species mentioned.

MH will inhibit flower initiation or development or both. Thus on plants where flowers or fruit are prized MH must be applied after flower initiation or development, or both, has occurred. For example, in oleander (in which flowers develop on the current year's growth) applications should be made at full bloom or shortly thereafter. Spring or summer applications may prevent flowering for the entire year, or may delay it several weeks if relatively low MH dosages are used. At

Davis, treatments in May inhibited flowering that would normally occur in July. July applications prevented stem elongation for the remainder of the year, but new growth the following spring bloomed normally in summer—thus, growth control was achieved without loss of bloom. *Pyracantha* initiates flowers in July and August; these flowers bloom the following spring and bear the colorful fall berries. Hence if berries are desired MH should be applied in August or September of the preceding year, as June or July application dates are likely to prevent berry set. April applications permit normal development of flowers initiated last summer.

Where it is desirable to inhibit flowering because of unsightliness, safety hazards or odor caused by falling fruits and flowers, MH treatment may provide a beneficial side effect. In American elms, for example, MH almost completely eliminates spring bloom and the consequent fall of flower and fruit parts. Other trees in which falling flowers or fruits may be a problem are orange *pittosporum*, black walnut, olive, and ginkgo.



Fig. 20. *Pyracantha coccinea* pruned in March. Plant in foreground treated with 0.25 per cent MH-30 5 days after bud break in March; photo was taken in April of same year. Note inhibition of shoot growth with normal flower development.



Fig. 21. Comparison of flowering on American elms treated with 1.33 per cent MH-30 in June, 1968 (right) and untreated (left). Note absence of flowers on treated tree. Photos in March, 1969.

SPECIES IN WHICH GROWTH HAS BEEN INHIBITED BY MH

Common name	Botanical name	Response*
Abutilon (flowering maple)	<i>Abutilon hybridum</i>	1
Acacia, Bailey	<i>Acacia baileyana</i>	3
Acacia, blackwood	<i>A. melanoxylon</i>	1
Alder, Italian	<i>Alnus cordata</i>	1
Alder, red	<i>A. rubra</i>	2
Ash, Oregon	<i>Fraxinus latifolia</i>	2
Ash, Shamel	<i>F. uhdei</i>	1
Bay, California (California laurel)	<i>Umbellularia californica</i>	1
Birch, paper	<i>Betula papyrifera</i>	1
Birch, white	<i>Betula verrucosa</i>	2
Bottlebrush	<i>Callistemon citrinus</i>	1
Box-elder	<i>Acer negundo</i>	2
Buckeye, California	<i>Aesculus californica</i>	2
Buckthorn, Italian	<i>Rhamnus alaternus</i>	1
Catalpa	<i>Catalpa speciosa</i>	1
Cotoneaster, box leaf	<i>Cotoneaster buxifolia</i>	1
Cotoneaster, silver leaf	<i>C. pannosa</i>	1
Cotoneaster, Parney	<i>C. parneyi</i>	1
Cypress, Monterey	<i>Cupressus macrocarpa</i>	1, 2
Cypress, smooth Arizona	<i>Cupressus glabra</i>	1
Dogwood, Pacific	<i>Cornus nuttallii</i>	2
Elderberry	<i>Sambucus californica</i>	2
Elm, American	<i>Ulmus americana</i>	1
Elm, Siberian	<i>U. pumila</i>	1
Eucalyptus (blue gum) sp.	<i>Eucalyptus globulus</i>	2
Eucalyptus, pink iron bark	<i>E. sideroxylon</i>	2
Eucalyptus, ribbon gum	<i>E. viminalis</i>	2
Fir, Douglas	<i>Pseudotsuga menziesii</i>	1, 2
Forsythia†	<i>Forsythia suspensa</i>	1
Grevillea (silk oak)	<i>Grevillea robusta</i>	2

Common name	Botanical name	Response*
Hibiscus†	<i>Hibiscus rosa-sinensis</i>	1
Ivy, English	<i>Hedera helix</i>	1
Jasmine, star†	<i>Trachelospermum</i> <i>jasminoides</i>	1
Juniper, Pfitzer	<i>Juniperus chinensis</i> 'Pfitzeriana'	1
Juniper, prostrate	<i>J. horizontalis</i>	1
Juniper, tam	<i>J. sabina</i> 'Tamariscifolia'	1
Lantana†	<i>Lantana</i> var.	1
Linden	<i>Tilia americana</i>	1
Madrone	<i>Arbutus menziesii</i>	2
Manzanita	<i>Arctostaphylos manzanita</i>	2
Maple, big leaf	<i>Acer macrophyllum</i>	2
Myrtle, wax	<i>Myrtus californiana</i>	2
Oak, black	<i>Quercus kelloggii</i>	1
Oak, blue	<i>Q. douglasii</i>	1
Oak, live	<i>Q. virginiana</i> , <i>Q. agrifolia</i>	1
Oak, tan bark	<i>Lithocarpus densiflora</i>	2
Oak, white	<i>Quercus alba</i>	1
Oleander†	<i>Nerium oleander</i>	1
Pine, Canary Island	<i>Pinus canariensis</i>	1
Pine, Monterey	<i>P. radiata</i>	1
Pine, Italian stone	<i>P. pinea</i>	1
Pine, jelecote	<i>P. patula</i>	1
Pittosporum, orange	<i>Pittosporum undulatum</i>	1
Plane, London (sycamore)	<i>Platanus acerifolia</i>	1
Poplar, Lombardy	<i>Populus nigra</i> 'Italica'	2
Privet, California	<i>Ligustrum ovalifolium</i>	1
Privet, Japanese	<i>L. lucidum</i>	1
Privet, waxleaf (Texas)	<i>L. japonicum</i>	1
Pyracantha	<i>Pyracantha coccinea</i>	1
Redbud, western	<i>Cercis occidentalis</i>	2
Redwood, coast	<i>Sequoia sempervirens</i>	1, 2
Viburnum, Japanese	<i>Viburnum japonicum</i>	1
Walnut, black	<i>Juglans hindsii</i>	1
Walnut, English	<i>J. regia</i>	1
Willow, black	<i>Salix gooddingii</i>	2
Willow, weeping	<i>S. babylonica</i>	1
Xylosma, shiny	<i>Xylosma congestum</i>	1

* Response ratings

1. Sufficient inhibition to eliminate at least one pruning when compared with untreated plants.
2. Sufficient inhibition to reduce the amount of pruning required and reducing the amount of brush to be handled; multiple applications may be necessary to get a rating of 1.
3. Poor control with single applications; multiple applications may be necessary.

† Flowering shrubs in which flowering may be inhibited or delayed unless care is taken in timing application.

AVERAGE BRANCH LENGTH AT 30-, 45-, AND 60-DAY INTERVALS BETWEEN MH TREATMENTS*

	Check length	Length in inches		
		30-day	45-day	60-day
<i>Rhamnus alaternus</i>				
Check (untreated)	3.0	—	—	—
0.1 per cent MH-30	—	0.4	0.4	0.4
0.25 per cent MH-30	—	0.3	0.2	0.6
<i>Ligustrum japonicum</i>				
Check (untreated)	14.6	—	—	—
0.1 per cent MH-30	—	4.3†	2.4†	6.7†
0.25 per cent MH-30	—	4.7†	4.3†	4.3†
<i>Viburnum japonicum</i>				
Check (untreated)	3.9	—	—	—
0.1 per cent MH-30	—	0.4‡	0.1‡	0.4
0.25 per cent MH-30	—	0.0†	0.0†	0.2
<i>Cotoneaster pannosa</i>				
Check (untreated)	24.0	—	—	—
0.1 per cent MH-30	—	9.8†	10.6†	16.5†
0.25 per cent MH-30	—	7.9†	9.1†	13.0†
<i>Cotoneaster parneyi</i>				
Check (untreated)	15.4	—	—	—
0.1 per cent MH-30	—	6.9†	3.7†	4.2†
0.25 per cent MH-30	—	2.5†	1.7†	5.8†

* Treatments started February 19, 1968; final measurement October 19, 1968.

† Some terminal buds killed; bud death not apparent until April 19, 1969.

‡ All terminal buds killed; young foliage not badly damaged.

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ABSTRACT

Chemical control with maleic hydrazide offers a cheaper, more convenient method for preventing overgrowth of trees and shrubs than does mechanical pruning. This chemical can be used safely and effectively when consideration is given to the following factors: time of application with respect to the plants annual growth cycle; optimal concentration of chemical; frequency of application.

Separate maintenance programs are recommended for plants to be viewed from more than 25 feet away and for those to be viewed at closer range. Effective chemical control can be obtained with both evergreen and deciduous trees and shrubs.

ACKNOWLEDGMENTS

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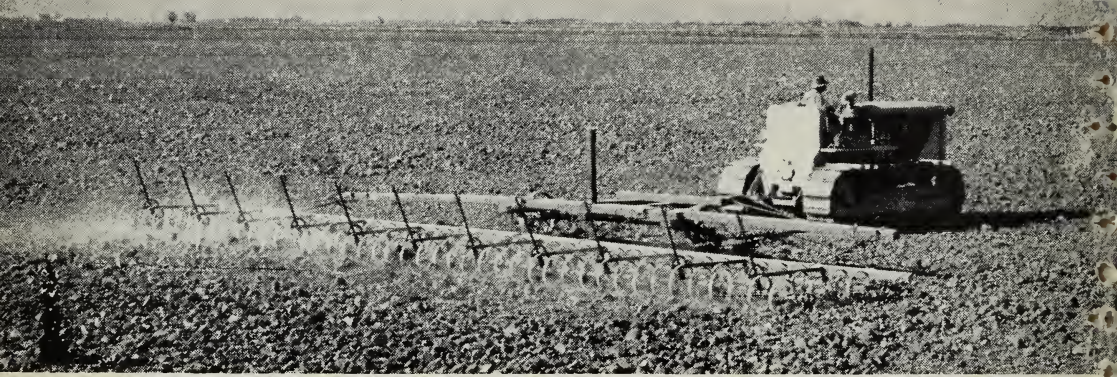
provided equipment with which to observe treated trees, and also provided consultation and information. The assistance of Mr. Richard Baldwin and Mrs. Marieka Jakobs-Coops is also acknowledged.

WARNING ON CHEMICAL RESIDUES

These recommendations are based on the best information currently available for each chemical listed. Treatments based upon these recommendations should not leave residues that will exceed the tolerance established for any particular chemical. To avoid excessive residues, follow directions carefully with respect to dosage levels, number of applications, and minimum interval between application and harvest.

THE USER IS LEGALLY RESPONSIBLE for problems caused by drift from his property to other properties or crops.

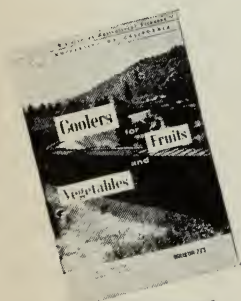
To simplify the information, it is sometimes necessary to use trade names of products or equipment. No endorsement of named products is intended nor is criticism implied of similar products not mentioned.



THE GOOD EARTH

... is the abundant earth. To achieve it, vast knowledge is needed now—and more will be required as expanding populations continue to make even greater demands upon the earth's resources.

How are scientists, researchers, and agriculturists developing and implementing knowledge which will make the good earth flourish for future generations? In part, the answer will be found in the many publications put out by the University of California's Division of Agricultural Sciences. Among these publications are:

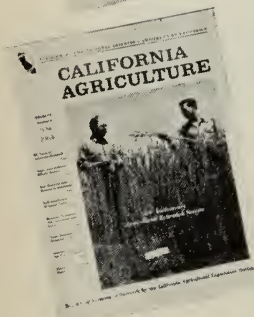


the **BULLETIN** series . . . designed for an audience of scientists, and for informed laymen interested in new research.

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